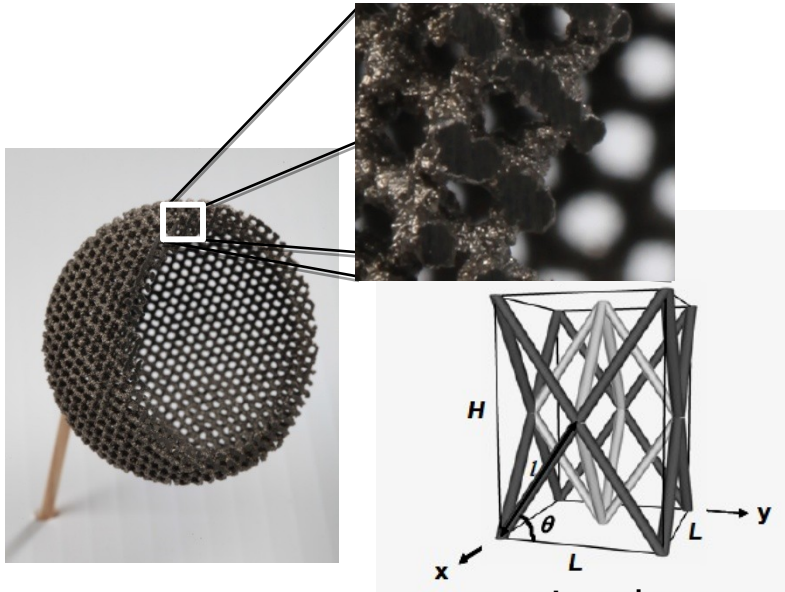


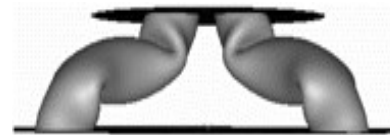
Mechanical Properties of Test Sphere (Across Different Length Scales)



Lattice-based unit cell

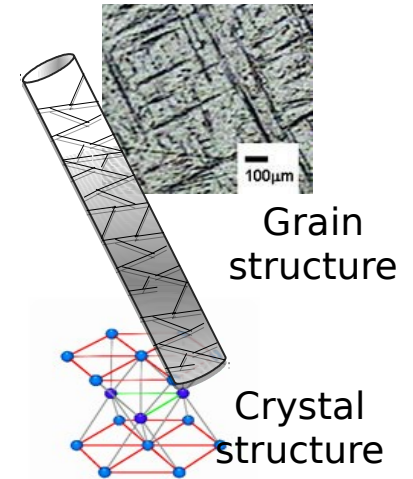


Plastic collapse (solid)



Plastic buckling (hollow)

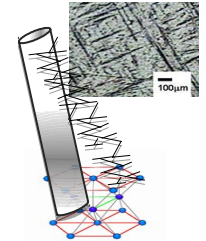
Hollow tube lattice member



Lattice-strut microstructure

Relevant Scale	cm - mm	mm - mm	mm - nm
Tunable Architectural Feature	3-D spatial location of truss elements	Orientation, aspect ratio, wall thickness	Composition, microstructure
E-Beam Processing Control	Overall 3-D geometry, node properties	Strut geometry and wall thickness	Grain structure, composition
Modeling approach	Macro-scale finite element analysis	Micro-scale finite element analysis	Molecular Dynamics

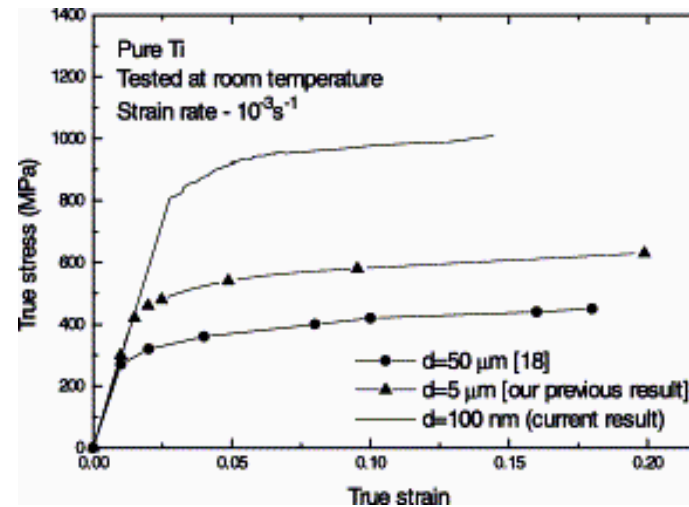
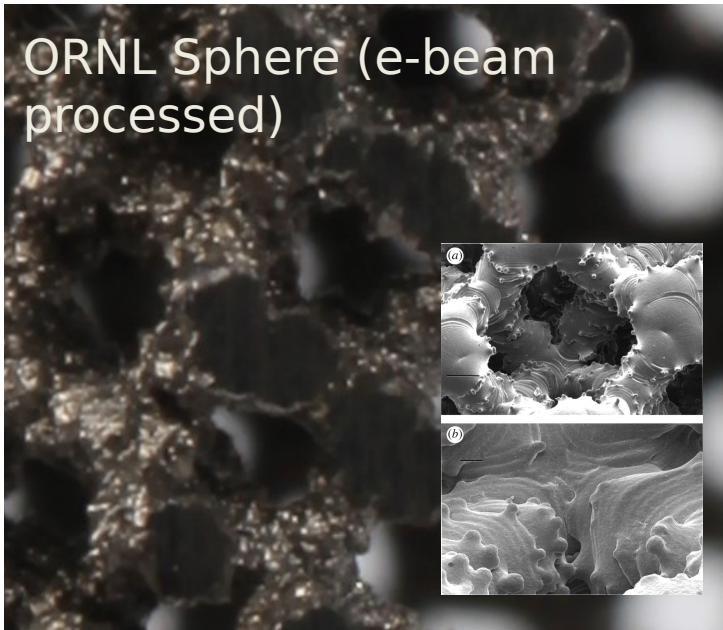
Properties of the Strut



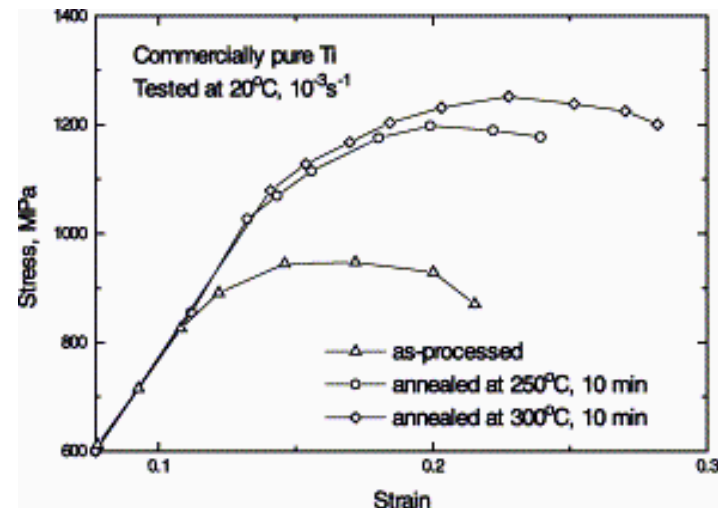
Critical Features

- Composition
- Microstructure
 - Grain size
 - Dislocation density/distribution
- Geometry/Topology

ORNL Sphere (e-beam processed)

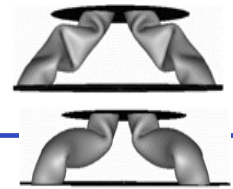


Grain size effect on strength



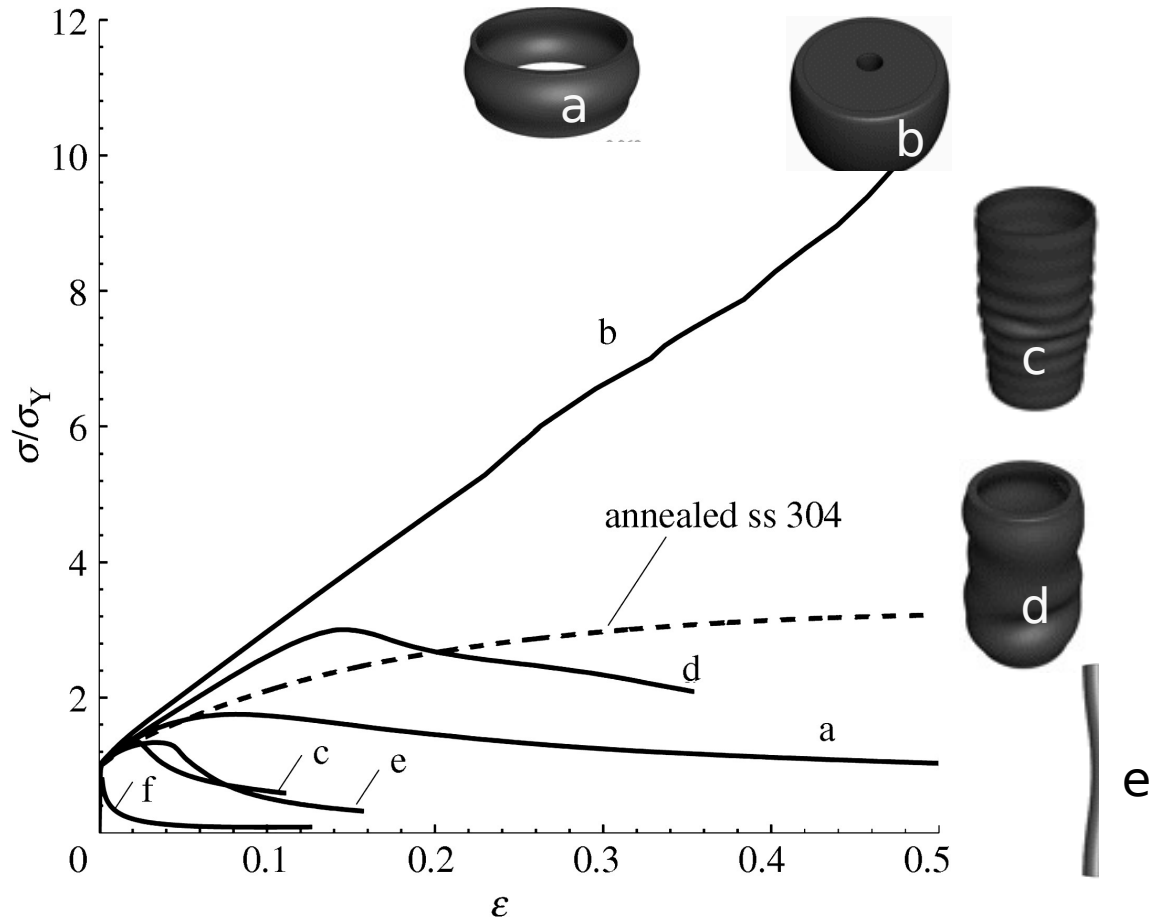
Dislocation effect on strength

Compressive Response for Different Strut Geometries Loaded Axially

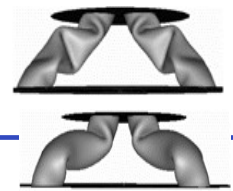


Mechanical behavior
of struts depends on:

- Material properties
– strength,
modulus...
- Geometry – solid
or tube will
change buckling
behavior
- Tube – wall
thickness will
control buckling

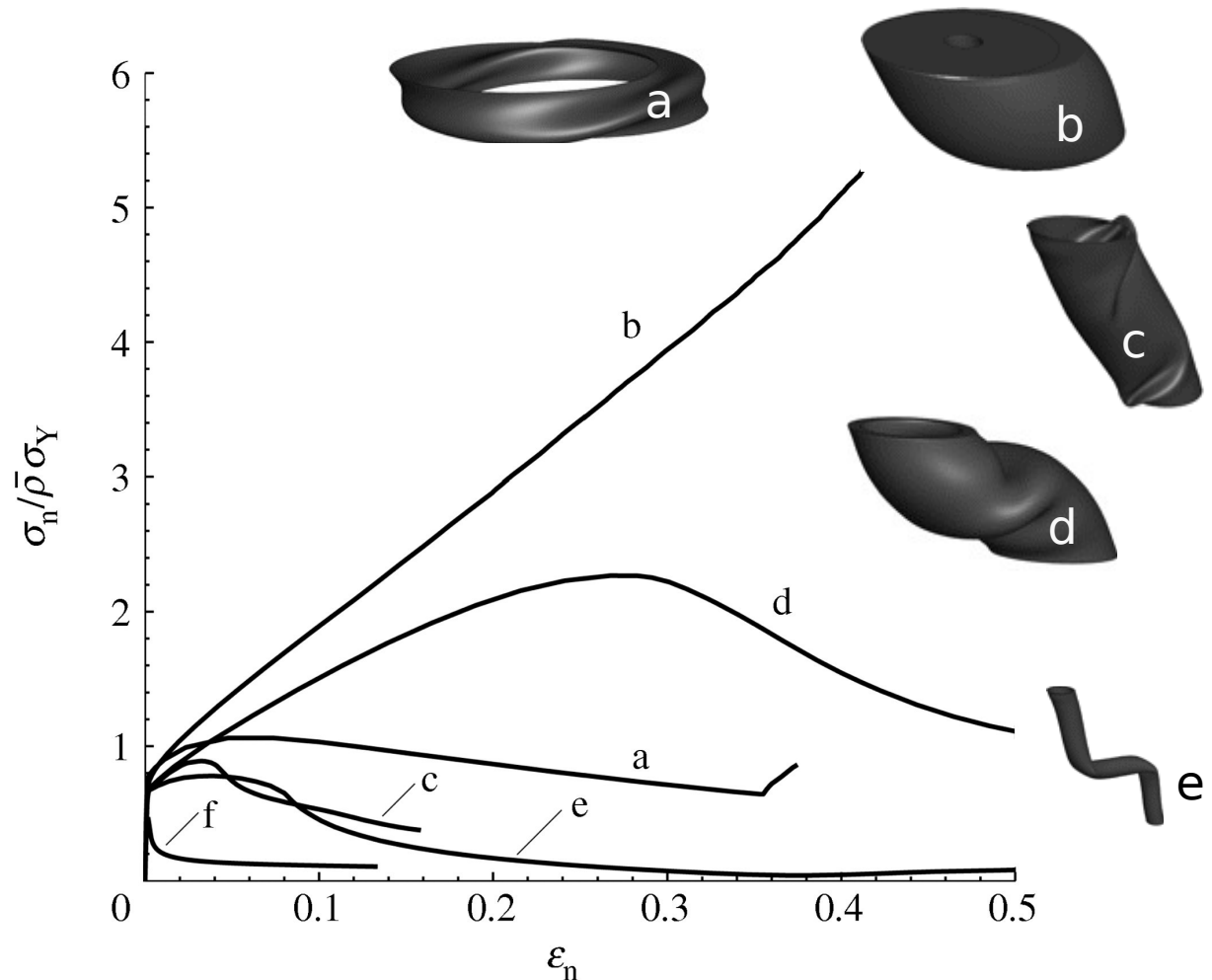


Compressive Response for Different Strut Geometries Loaded at an Incline



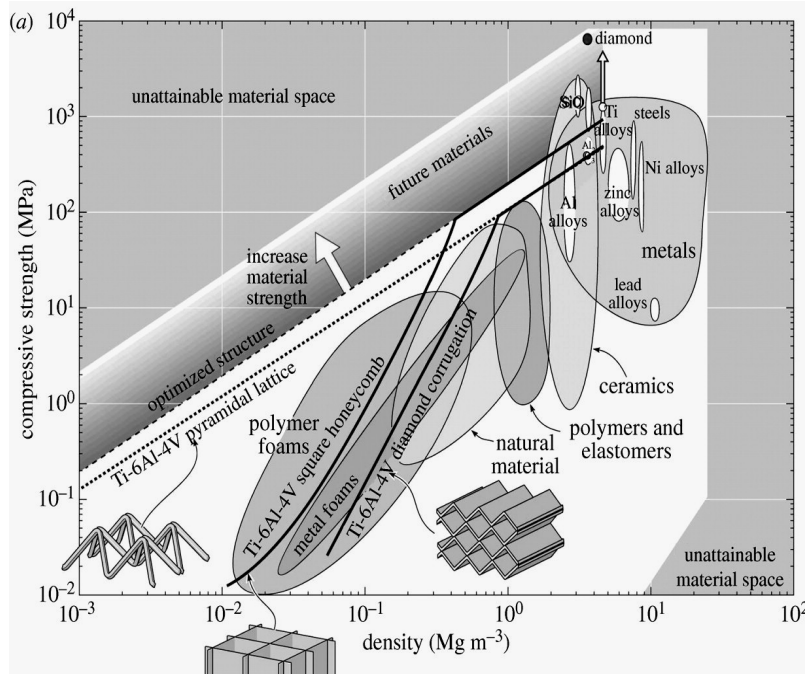
Mechanical behavior of struts load on an incline:

- Buckling will depend on load path
- Mechanical properties of nodes where struts connect are critical
- Tube - wall thickness will control buckling



Properties at the Lattice Scale

Compressive Strength vs. Density of Lattice Materials



Lattice materials allow for more efficient structural loading under compression

Structural efficiency of hollow stainless steel trusses under compression

